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Traulsen, Marie Lund; Walker, R. A.; Holtappels, Peter

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In Operando Raman spectroscopy for investigation of solid oxide electrolysis cells

Marie Lund Traulsen^a, R. A. Walker^b, Peter Holtappels^a

^aTechnical University of Denmark, DTU Energy; ^b Montana State University, Department of Chemistry and Biochemistry

Raman spectroscopy is an optical, vibrational spectroscopy well suited for in operando investigations, as the technique can be applied at the temperatures and gas pressures used during operation of solid oxide electrolysis cells.

For this reason DTU Energy has invested in a Raman lab dedicated to in operando investigation of solid oxide electrolysis cells - and other electrochemical systems.

In operando monitoring of carbon depositions in a Ni-YSZ cell

The carbon deposition in 50% CO/50% CO₂ at 750 °C was followed on a symmetric Ni-YSZ cell mounted vertically in the test-house to allow for monitoring of the electrochemiacally active region.

Figure 2. The mounting of the Ni-YSZ symmetric cell in the Linkam stage



Figure 3. Optical microscopy image of the cell cross-section



Figure 4. Raman spectrum recorded at 750 °C in humidified hydrogen

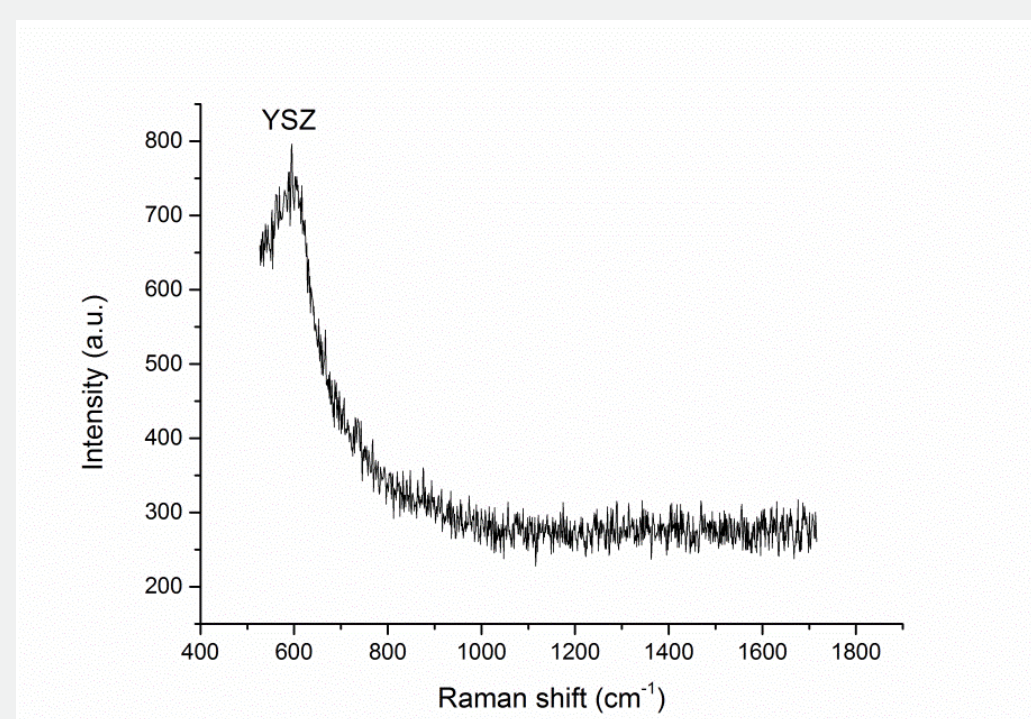


Figure 5. Raman spectrum recorded at 750 °C 50% CO /50% CO₂ mixture

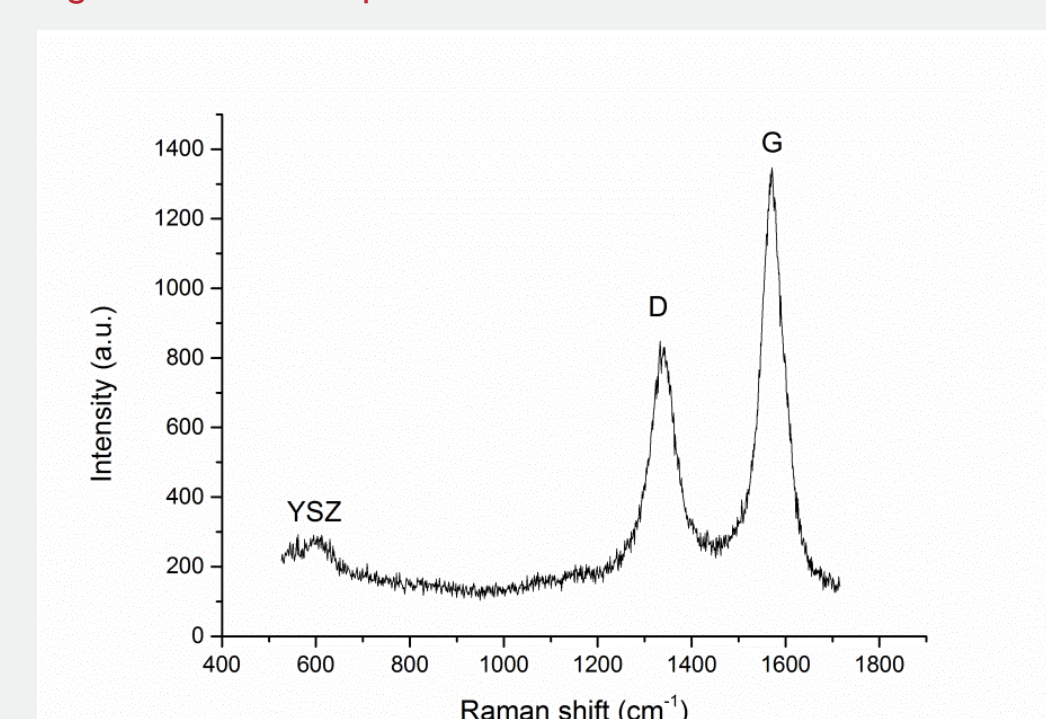


Figure 6. EIS recorded at 750 °C in humidified hydrogen and 50% CO /50% CO₂ mixture

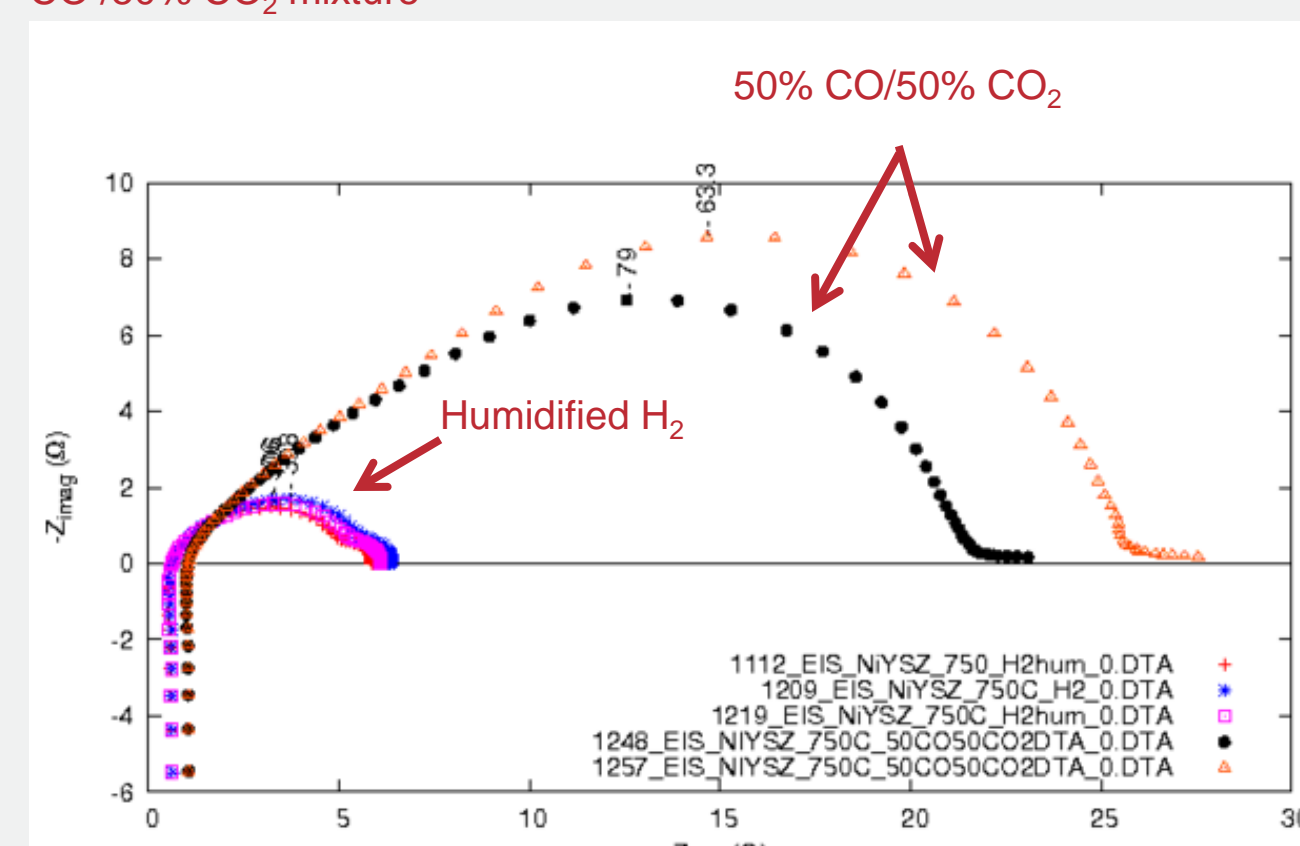
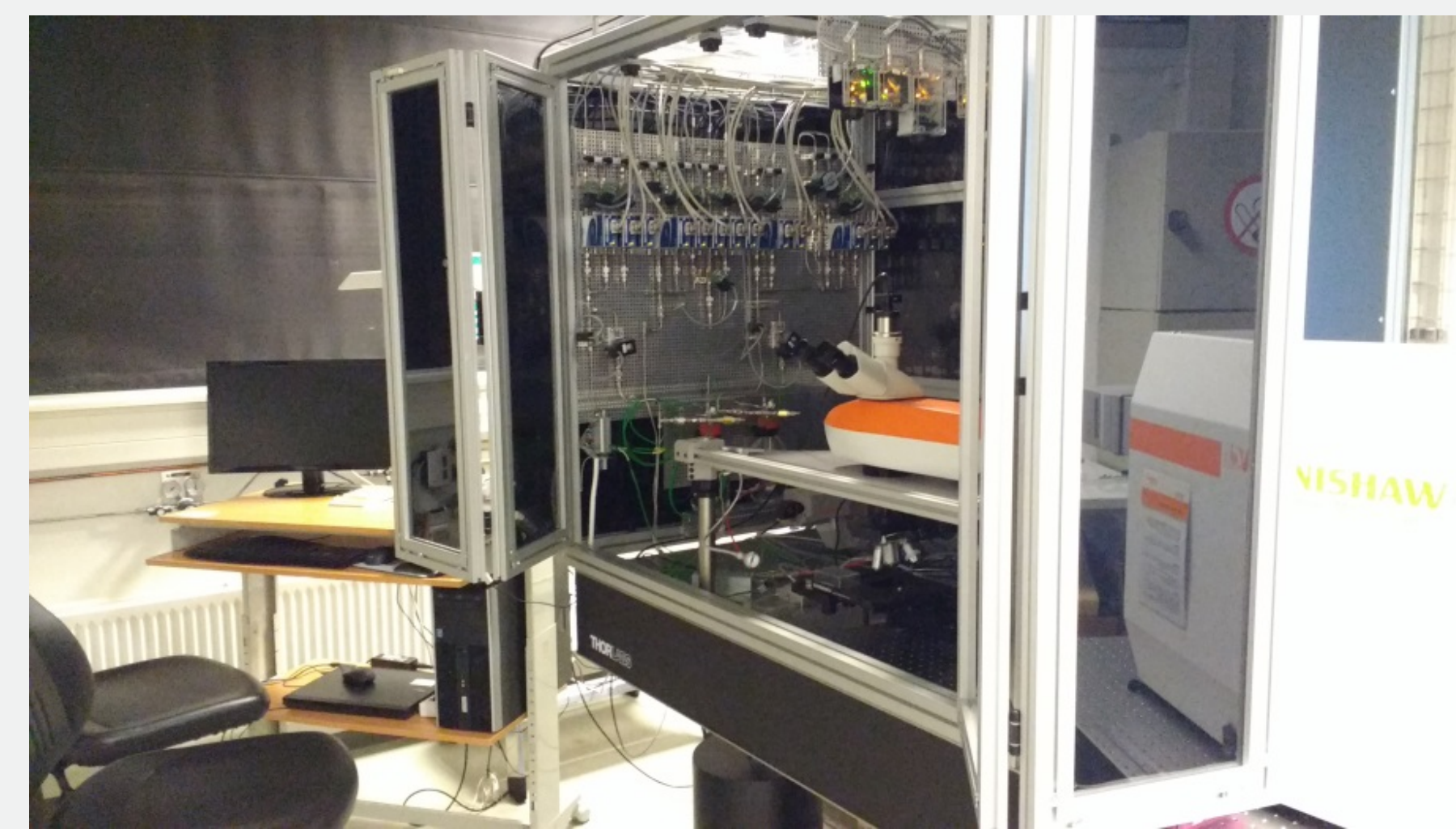


Figure 1. The Raman lab facility at DTU Energy



Available in the Raman lab:

- Renishaw inVia Raman spectrometer
- 3 lasers: 785 nm (NIR), 532 nm (VIS), 325 nm (NUV)
- A wide range of gasses: O₂, Ar, N₂, CO₂, CO, CH₄, H₂, 9% H₂ in N₂, 1% Propen (C₃H₈) in Ar, 1% NO in Ar, 200 ppm H₂S in H₂
- Different testhouses/teststations...

Reversible Decomposition of Secondary Phases in BaO Infiltrated LSM Electrodes—Polarization Effects

Compositional changes in BaO-modified lanthanum strontium manganite (LSM) electrodes where observed during electrical polarization. The applied cathodic potential resulted in a reversible decomposition of a secondary Ba₃Mn₂O₈ phase

Figure 7. Top-view of LSM thin film electrode surface with Au current collectors

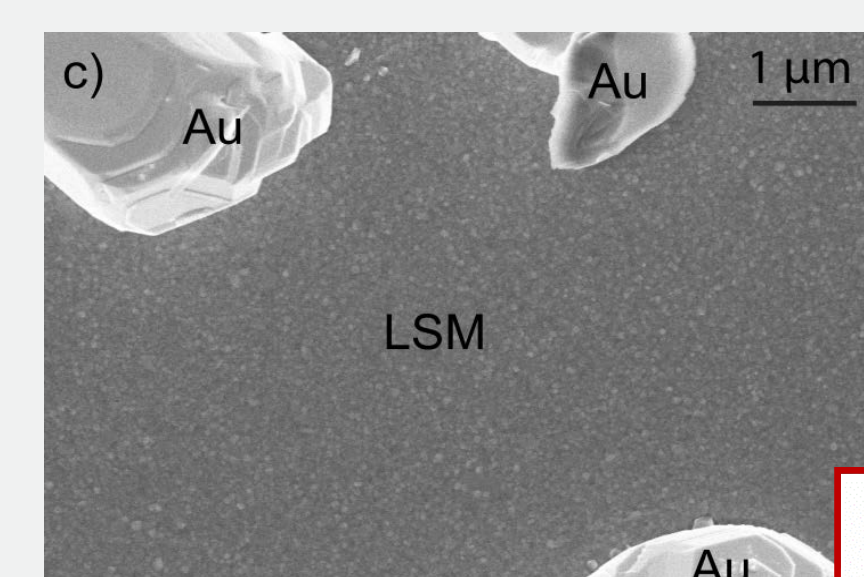


Figure 8. Top-view of LSM thin film electrode surface with Au current collectors and with BaO deposition

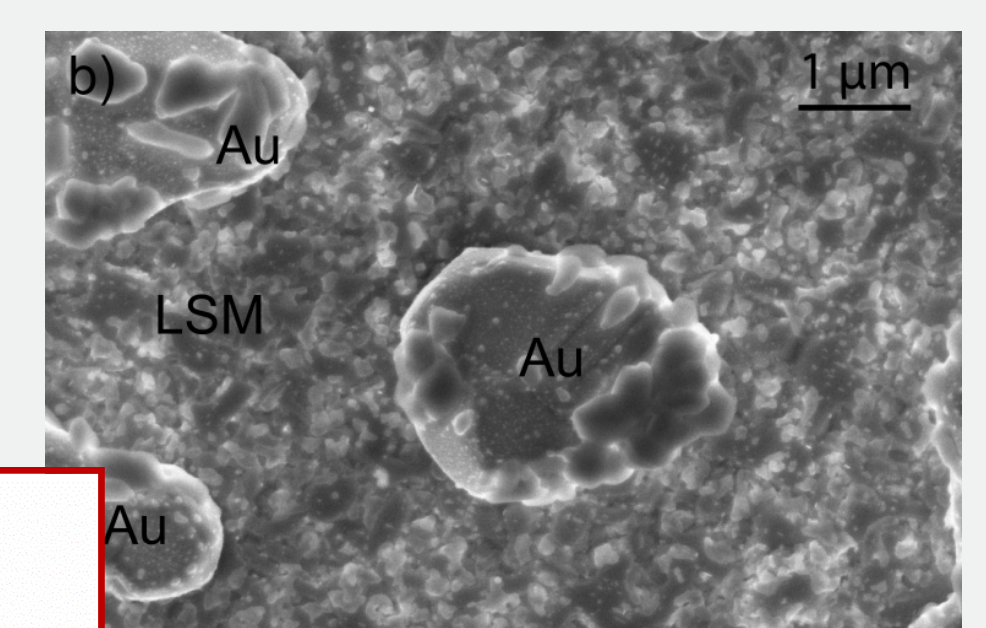
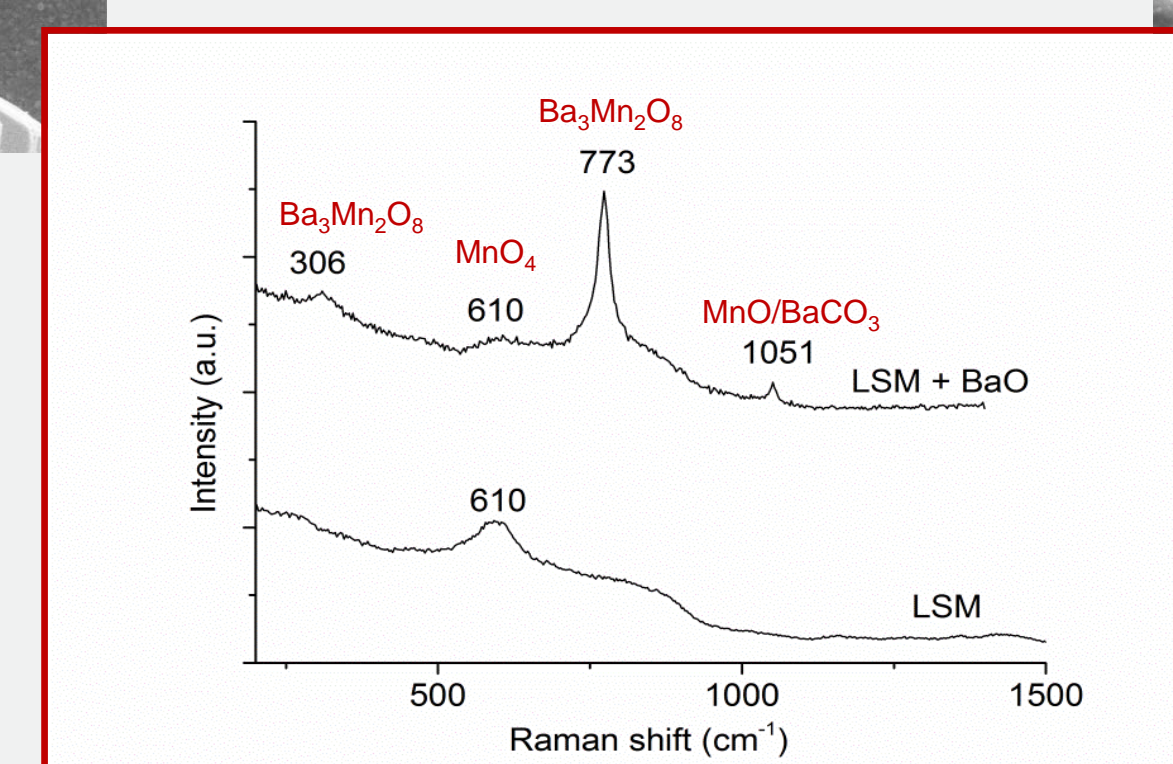


Figure 9. Raman spectra recorded on a LSM thin film electrode without and with BaO modification



Raman shift (cm ⁻¹)	Assignment
306	Ba ₃ Mn ₂ O ₈
610	MnO ₄
644	Mn ₂ O ₄
773	Ba ₃ Mn ₂ O ₈
1051	MnO/BaCO ₃

Figure 10. Onset of -1V cathodic polarization

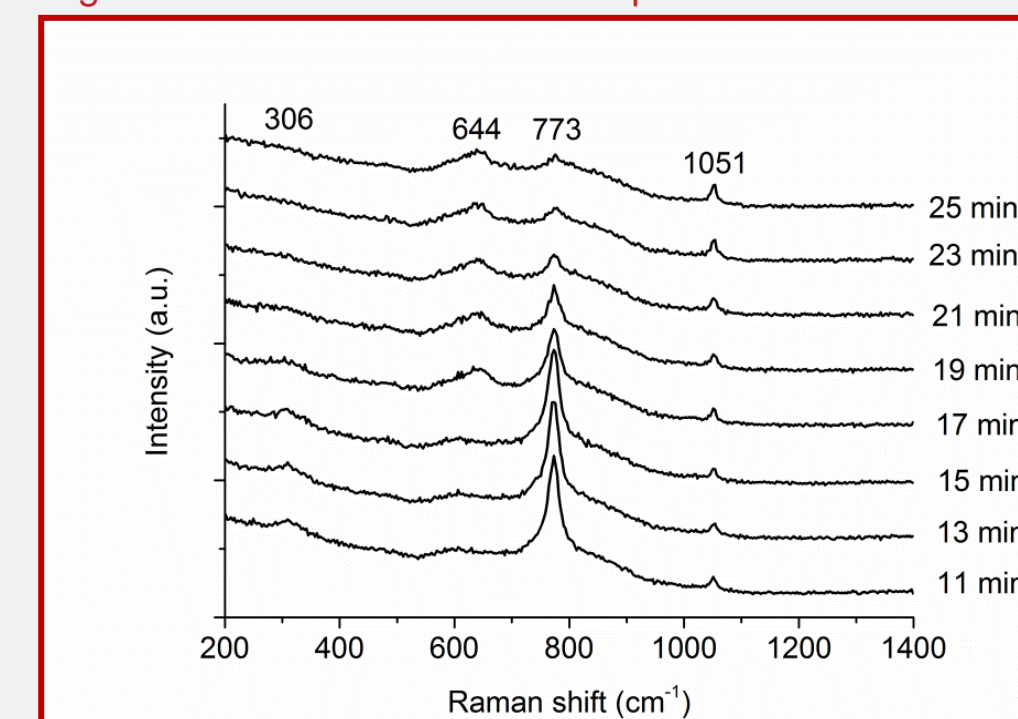


Figure 11. Returning to OCV after -1V cathodic polarization

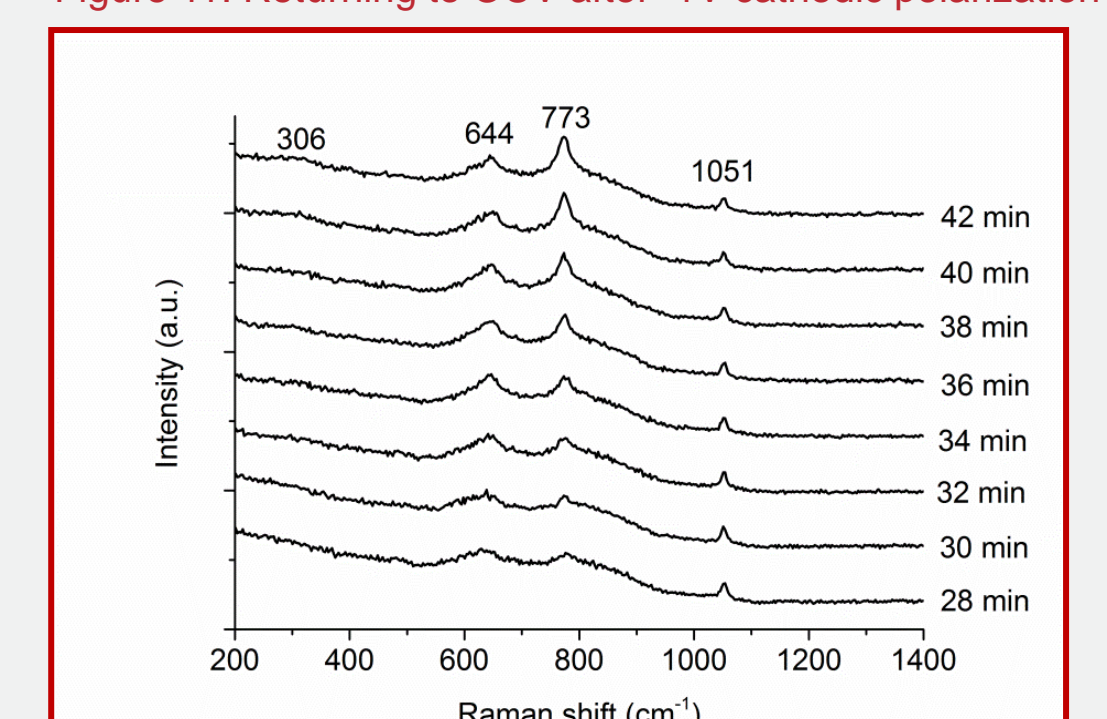
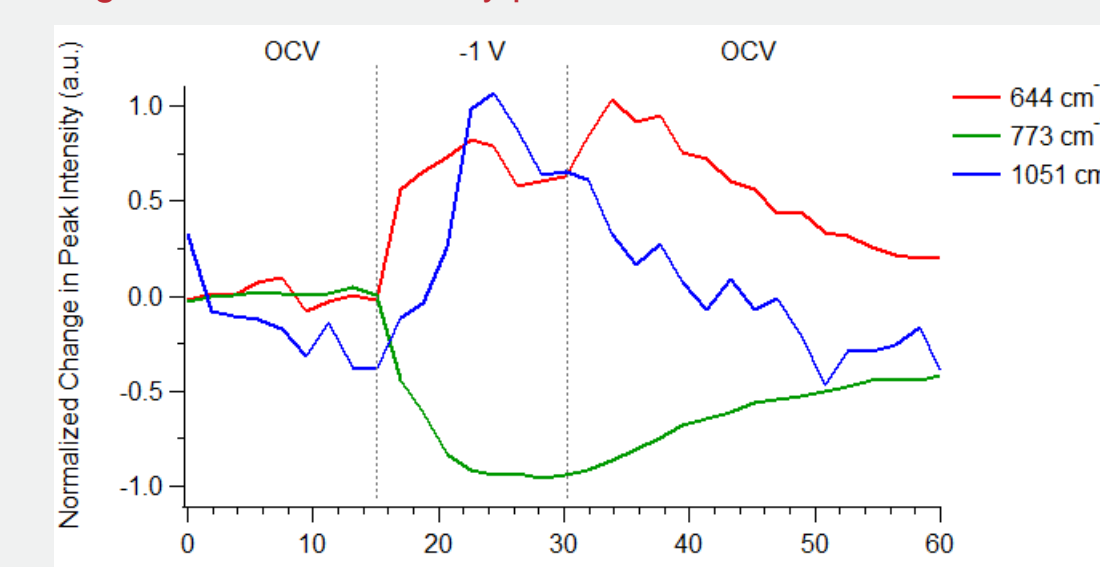


Figure 12. Peak intensity plot



Results published by
M. L. Traulsen, M.D. McIntyre, K. Norman,
S. Sanna, M. B. Mogensen, and R. A. Walker
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